The flexibility of the language production system

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Abstract

The selection of an appropriate word from other meaning-related competitors is a main function of language production. Recent inconclusive findings have casted doubt about traditional lexical selection accounts. The swinging lexical network (SLN) account presents a competitive framework that formulates specific conditions under which semantic facilitation or interference effects can be observed in picture naming paradigms. These specific conditions concern a) the manipulation of the trade-off between conceptual facilitation and lexical interference, b) the extent of lexical cohort activation and c) the flexible nature of the language production system. The trade-off assumption was assessed by investigating the impact of associations on naming latencies in the continuous naming paradigm in which semantically related items are named within a seemingly random sequence (Study 1). Information for the understanding of lexical cohort activation on word production was obtained by manipulating semantic distance in the continuous naming paradigm combined with event-related potentials (ERP; Study 2). Aiming at testing the flexibility assumption, effects of unrelated meaning alternatives of homophones in a picture-word interference (PWI) paradigm were investigated, after participants repeatedly processed linguistic ambiguities (Study 3).

Results show semantic interference for associates and for closely related category co-ordinates in the continuous naming paradigm (Study 1 & 2), and facilitation effects for homophone names in the PWI after the cognitive system adapted to the processing of linguistic ambiguities (Study 3). Closely related stimuli modulated ERPs in the P1, between 250 and 400 ms, and in the N400 time window, which are known to be associated with single word naming processes. These results support the SLN model and enhance the understanding of semantic and cognitive factors that shape the microstructure of language production.

Zusammenfassung

Die Auswahl eines passenden Wortes aus semantisch verbundenen Wettbewerbern ist eine wesentliche Funktion der Sprachproduktion. Neuere strittige Befunde scheinen traditionellen lexikalischen Selektionsmodellen zu widersprechen. Der *swinging lexical network* (SLN) Ansatz offeriert eine kompetitiven Bezugsrahmen, der spezifische Voraussetzungen formuliert, unter denen semantische Erleichterungs- als auch Interferenzeffekte in Bildbenennungsparadigmen beobachtet werden können. Diese spezifischen Voraussetzungen betreffen a) die Manipulation eines Trade-offs zwischen konzeptueller Erleichterung und lexikalischer Interferenz, b) das Ausmaß an lexikalischer Kohortenaktivierung und c) die flexible Anpassungsfähigkeit des Sprachproduktionssystems. Die Trade-off-Annahme wurde durch Einflüsse von Assoziationen auf die Benennungslatenz untersucht (Studie 1), wenn Stimuli im kontinuierlichen Benennungsparadigma in einer scheinbar zufälligen Reihenfolge benannt werden. Information über den Einfluss lexikalischer Kohortenaktivierung auf die Wortproduktion wurde durch Manipulation semantischer Distanz und durch Kombination des kontinuierlichen Benennungsparadigmas mit ereignis-korrelierten Potentialen (EKPs) gewonnen (Studie 2). Zur Überprüfung der Flexibilitätsannahme werden Benennungslatenzen von Homophonen mittels Bild-Wort-Interferenzparadigma untersucht, nachdem Versuchspersonen wiederholt linguistische Mehrdeutigkeit verarbeiten haben (Studie 3).

Die Ergebnisse zeigen semantische Interferenzeffekte für assoziativ und für eng kategorial verbundene Stimuli im kontinuierlichen Benennungsparadigma (Studie 1 & 2) und Erleichterungseffekte für Homophone im PWI, nachdem das kognitive System sich auf Mehrdeutigkeit adaptiert hatte (Studie 3). Eng kategorial verbundene Stimuli modulierten EKP-Komponenten in der P1, zwischen 250 und 400 ms und im N400-Zeitfenster, welche mit Wortproduktions-prozessen in Verbindung gebracht werden. Diese Ergebnisse unterstützen den SLN Ansatz und tragen zum besseren Verständnis semantischer und kognitiver Einflussfaktoren auf die Sprachproduktion bei.

Synopsis

1. Introduction

In the field of neurocognitive psychology, language is considered as a mental faculty that allows humans to learn, to produce and to comprehend verbal information. Language allows us to communicate with each other and to express diverse aspects of our inner and outer world. For this purpose, words are stored as lexical entries in the mental lexicon. In general, we perceive the production of words as effortless. We even play with their multifaceted meanings, for instance, by telling puns (cf. Bekinschtein, Davis, Rodd, & Owen, 2011). However, we also struggle to find the adequate words to convey our ideas. In fact, several alternative words seem at first adequate to express an intended message. That is why the speaker has to select the appropriate word from other meaning-related alternatives. This dissertation aims to investigate processes of lexical selection with respect to the impact of semantic and cognitive factors. According to the swinging lexical network (SLN), language production depends on a) the outcome of a trade-off between semantic and lexical processes that is influenced by b) the activation of meaning-related cohorts. One additional assumption of this account is that c) language production can be flexibly shaped by situational conditions. In this work, we take a closer look at these three assumptions. **Study 1** deals with predictions made by the trade-off assumption for associatively related concepts. The impact of activated meaning-related lexical cohorts is elucidated in **Study 2** by investigating semantic distance effects. Finally, **Study 3** deals with the flexibility assumption by assessing whether the processing and comprehension of puns can influence the microstructure of homophone production.

2. Theoretical background

Language production consists of conceptual, lexical and phonological processing levels. A core assumption of most language production models is that during naming of a picture (e.g., of a dog) the activation from a concept not only activates semantically related concepts (e.g., cat, cow or rabbit), but also the corresponding lexical representations, called lemma, which contain syntactic information (e.g., Dell, 1986; Levelt, 1992; Levelt, Roelofs, & Meyer, 1999; Roelofs, 1992). As a result, the to-be-selected target lemma competes with other co-activated lemmas for selection, and efficiency of lexical selection is dependent on the activation level of the target lemma compared to the sum of activations of all other simultaneously active lemmas (Roelofs, 1992, 2003). After a lemma is selected, its phonological code, namely its morphological, metrical and segmental information, is encoded. At this stage, the phonological retrieval can be influenced by the activation of non-target lemmas due to continuous information flow, especially when these co-activated representations share phonological information (e.g., homophones) (Cutting & Ferreira, 1999; Ferreira & Griffin, 2003; Taylor & Burke, 2002; see also Dell & O'Seaghdha, 1991).

2.1. Lexical selection in single word production

Insights into word production processes are gained by various picture-naming paradigms (e.g., picture-word interference, cyclic naming blocking, and continuous naming). In the picture-word interference (PWI) paradigm, a picture (e.g., of a cow) is simultaneously presented with a to-be-ignored distractor word that can be either semantically related (e.g., dog) or unrelated (e.g., knife) with the target. The fact that the target picture's naming latencies are prolonged for semantically related distractors relative to unrelated distractors, has been taken as evidence for lexical competition (e.g., Damian &

Bowers, 2003; Glaser & Dungelhoff, 1984; Glaser & Glaser, 1989; Hantsch, Jescheniak, & Schriefers, 2005; Schriefers, Meyer, & Levelt, 1990). The PWI paradigm may also shed light on the production of ambiguous words, such as homophones sharing the same phonological code but having semantically unrelated semantic-lexical representations (e.g., ball: sports device vs. gathering for a dance). PWI studies using distractors that are semantically related to the non-depicted meaning of a homophone showed phonological facilitation effects (Cutting & Ferreira, 1999; Taylor & Burke, 2002). These findings were explained by propagating activity from the activated distractor lemma to the lemmas of the alternative meaning, and by priming of the shared phonological word form.

Further evidence for lexical competition stems from semantic interference effects in the cyclic blocking paradigm, during which several objects are repeatedly presented in cycles of blocks either containing semantically related objects (homogenous blocks; e.g., dog, cat, cow, rooster, etc.) or semantically unrelated objects (heterogeneous blocks; e.g., dog, fork, apple, couch, etc.). Naming latencies are delayed in homogenous blocks compared to heterogeneous blocks (e.g., Belke, Meyer, & Damian, 2005; Damian & Als, 2005; Damian, Vigliocco, & Levelt, 2001; Kroll & Stewart, 1994; Schnur, Schwartz, Brecher, & Hodgson, 2006; Vigliocco, Vinson, Damian, & Levelt, 2002). A variant of this paradigm is the continuous naming paradigm, in which semantically related objects are presented in a seemingly random sequence and separated by 2 to 8 different unrelated objects. Naming latencies linearly increase with each named item from the presented category irrespective of lag length, or in other words, with the ordinal position of an item within the presented category (e.g., Belke, 2013; Belke & Stielow, 2013; Costa, Strijkers, Martin, & Thierry, 2009; de Zubicaray, McMahon, & Howard, 2013; Howard, Nickels, Coltheart, & Cole-Virtue, 2006; Navarrete, Mahon, & Caramazza, 2010; Runnqvist, Strijkers, Alario, & Costa, 2012).

These long lasting and cumulative semantic interference effects in the continuous naming paradigm irrespective of lag length have been explained by an additional learning mechanism that enhances the connection between semantic and lexical representations (Howard et al., 2006) or between conceptual features and concepts (Belke, 2013) each time a target lemma has been selected. Consequently, a previously selected lemma becomes a stronger competitor when it is co-activated by another semantically related item in later trials. Alternatively, this pattern can also be explained by an incremental learning mechanism that enhances the next retrieval of a previously selected lexical form by strengthening its semantic-lexical connections, and at the same time inhibits the retrieval of semantically co-activated but not-selected items by diminishing their semantic-lexical connections (Oppenheim, Dell, & Schwartz, 2010). Critically, this model does not assume a competitive mechanism for lexical selection. Lexicalization is achieved by a booster mechanism that calibrates the activation of targets and non-target lemmas until one exceeds a certain threshold (but see de Zubicaray, McMahon, et al., 2013; Riès, Karzmark, Navarrete, Knight, & Dronkers, 2015).

The continuous naming paradigm considerably differs from the PWI and cyclic naming paradigm. Precisely, activation in this paradigm is characterized by semantic co-activation induced by the current target and by a learning mechanism that linearly enhances lexical competition each time a member of a semantic category has been named. Due to interspersed unrelated items, semantic activation patterns from a target should drop significantly after the target has been named (Howard et al., 2006). Thus, whereas in the other paradigms the impact of conceptual activation on semantic interference cannot be disentangled, this is possible in the continuous naming paradigm (for further details see Rose & Abdel Rahman, 2016).

Recently, inconclusive and heterogeneous findings have casted doubt about the viability of traditional competitive language production accounts. Competitive models predict that the degree of semantic interference between semantically related stimuli is determined by the amount and level of activation propagating within as well as between semantic-lexical layers (e.g., Roelofs, 1992; Vigliocco et al., 2002). While some studies found semantic distance effects in the form of larger picture naming latencies (e.g., pig) for closely related stimuli (e.g., goat) relative to distantly related stimuli (e.g., duck) (e.g., Aristei & Abdel Rahman, 2013; Navarrete, Del Prato, & Mahon, 2012, Experiment 3; Vieth, McMahon, & de Zubicaray, 2014a, Experiment 2; Vigliocco et al., 2002; Vigliocco, Vinson, Lewis, & Garrett, 2004), other studies showed that semantic distance did not affect the size of semantic interference above and beyond broad category membership (e.g., Hutson & Damian, 2014; Navarrete et al., 2012, Experiment 2; Vieth et al., 2014a, Experiment 1). One study even found a polarity reversal in the form of stronger interference for distantly related than for closely related distractors (Mahon, Costa, Peterson, Vargas, & Caramazza, 2007).

Moreover, research in language production mainly focused on categorical relations (e.g., beer and wine). Associative relations (e.g., bar and wine) have gained far less attention, even though associations are an important part of semantic memory (Estes, Golonka, & Jones, 2011; McRae, Khalkhali, & Hare, 2012; Muehlhaus et al., 2013). For instance, based on every-day experience, they help to generate expectations about certain situations (e.g., what to typically order in a bar). Traditional accounts assume comparable semantic interference effects for associative and categorical relations, but effects of these relations on lexical retrieval seem to diverge. Robust interference effects for associations have not been found yet. In contrast, the presentation of the associatively related distractor words in a PWI induces no effects or semantic facilitation instead of interference (e.g., Abdel Rahman & Melinger, 2007; Alario, Segui, & Ferrand, 2000; Aristei, Melinger, &

Abdel Rahman, 2010; Bloem, van den Boogaard, & La Heij, 2004; Costa, Alario, & Caramazza, 2005; de Zubicaray, Hansen, & McMahon, 2013; La Heij, Dirkx, & Kramer, 1990).

All together, these findings seem at odds with assumptions of traditional competition models. In particular, several authors argued that facilitation effects for associative and closely related distractors is incompatible with traditional competitive models, and several alternative non-competitive accounts have been proposed (e.g., Mahon et al., 2007; Navarrete et al., 2012; Navarrete, Del Prato, Peressotti, & Mahon, 2014). However, the observation of facilitatory semantic context effects is per se not problematic for lexical competition models (cf. Roelofs & Piai, 2013; Roelofs & Piai, 2015), since context-induced semantic priming is considered by most competitive models (e.g., Belke, 2013; Levelt et al., 1999; Roelofs, 2003).

2.3. The swinging lexical network account

The swinging lexical network (SLN) account (Abdel Rahman & Melinger, 2009a, 2009b) postulates that the polarity of semantic context effects are a product of a trade-off between facilitatory semantic priming at the conceptual level and co-occurring inhibitory competition at the lexical level. According to this view, one main factor required for lexical competition to outweigh conceptual facilitation is the activation of a lexical cohort, defined as a number of co-activated and inter-related competitors that contribute to the overall level of activation and competition. Additionally, one feature of this account is that it incorporates flexible changes or adaptations in activation patterns with regard to situational conditions (e.g., specific discourse contexts).

Furthermore, categorical and associative semantic relations differ in their likelihood to induce the activation of a lexical cohort (Abdel Rahman & Melinger, 2007, 2009a, 2009b). Categorical relations induce the activation of a large cohort of lexical items because of a high degree of semantic feature overlap with other members of the same category. In contrast, associates do not share a high amount of category-specific feature overlap and do not induce lexical cohort activation (cf. de Zubicaray, Johnson, Howard, & McMahon, 2014). Consequently, conceptual facilitation effects dominate. However, associative interference can be detected when lexical cohort activation is boosted and/or when the impact of conceptual facilitation is curtailed. Thus, associates elicit interference effects in the cyclic blocking paradigm. Because associates are repeatedly presented in blocks (e.g., bee, honey, honey comb, beekeeper), activation of a lexical cohort is achieved, and inhibitory competition effects from the cohort outperform conceptual facilitation effects (Abdel Rahman & Melinger, 2007). Moreover, distractor words (e.g., camera) that are only phonologically related to the associate (e.g., camel) of the target picture (e.g., pyramid) yield mediated semantic interference effects. These distractors can circumvent conceptual facilitation effects because they only activate the shared word form but not the associate's concept (Melinger & Abdel Rahman, 2013). However, these reported associative interference effects are very small, and have not been replicated (cf. de Zubicaray et al., 2014). It remains unclear whether associates have the same potential to yield interference as category co-ordinates. **Study 1** investigated the impact of associative relations in the continuous naming paradigm. Here, impacts of conceptual activation should be minimal, and according to the trade-off assumption, associative interference is predicted. Please note, even though the SLN does not explicitly postulates a learning mechanism between processing stages (Belke, 2013; Howard et al., 2006), this can be accounted for by long-lasting effects due to postulated dynamic network modulations (Abdel Rahman & Melinger, 2009b; see Rose & Abdel Rahman, 2016 for further details).

Furthermore, the lexical cohort assumption can principally also explain the reported polarity reversal of semantic distance effects with higher interference for distantly compared to closely related items reported by Mahon and colleagues (Mahon et al., 2007). In this instance, the SLN would predict that closely related stimuli (e.g., chimpanzee, gorilla, orangutan, etc.) sharing many specific features might activate a small and narrow cohort, while distantly related stimuli (e.g., crocodile, bee, bear, etc.) mainly share general features and activate a larger cohort. Accordingly, semantic interference should be strongest for the semantically distant compared to the close condition (Abdel Rahman & Melinger, 2009a, 2009b; but see Aristei & Abdel Rahman, 2013; Hutson & Damian, 2014; Vieth et al., 2014a). **Study 2** investigates semantic distance effects in the continuous paradigm and can provide information about the validity of this assumption. Semantic distance was manipulated within taxonomic hierarchies. Stimuli varied according to the membership to a basic level (e.g., apes: chimpanzee, gorilla, etc.) or superordinate category (e.g., animals: birds, fishes, etc.), and broad category membership was kept constant. Following the lexical cohort assumption, membership of a basic level category would result in activation of a small cohort (e.g., only apes), whilst membership of a superordinate category would yield activation of a larger cohort (e.g., several different animals).

The flexibility assumption of the SLN predicts that context effects are not limited to hard-wired representations in the semantic system (as e.g., categorical or associative relations), but can also be observed for relations that are created ad hoc due to situational needs (Barsalou, 1983, 2008). Thus, it has been shown that semantically unrelated objects (e.g., rice, camera, gift box, altar) can yield semantic interference effects in the cyclic blocking paradigm, when they are interrelated by a meaningful context (e.g., wedding) (Abdel Rahman & Melinger, 2011). However, these ad hoc relations can be considered, for instance, as a part of long-term memory in the form of event knowledge (e.g., Estes et al.,

2011). The question remains open whether comparable effects could be also observed for words that are by no means semantically related. **Study 3** investigated flexible changes in activation patterns during the PWI task with objects having a homophone name. Precisely, this study examined whether the processing of linguistic ambiguities in the form of puns would influence the co-activation pattern of unrelated alternative homophone meanings.

2.4. Mental chronometry of language production processes

In recent years, an increasing number of PWI and cyclic blocking studies combined the technique of event-related potentials (ERPs) retrieved from the registration of the continuous electroencephalogram (EEG) with overt naming. ERPs provide high temporal resolution and are an ideal tool for investigating different stages of single word production processes. Previous EEG studies indicate that lexical retrieval processes are associated with modulations starting around 200 ms (e.g., Aristei et al., 2010; Blackford, Holcomb, Grainger, & Kuperberg, 2012; Costa et al., 2009; Dell'Acqua et al., 2010; Greenham, Stelmack, & Campbell, 2000; Maess, Friederici, Damian, Meyer, & Levelt, 2002; Piai, Roelofs, Jensen, Schoffelen, & Bonnefond, 2014; Piai, Roelofs, & van der Meij, 2012; Strijkers, Costa, & Thierry, 2010). Thereby, effects around 200 ms at posterior electrodes most likely reflect semantic-lexical co-activation during lexical retrieval (e.g., Aristei et al., 2010; Costa et al., 2009; Maess et al., 2002; Strijkers et al., 2010), whereas N400 effects at fronto-central electrodes have been interpreted to reflect facilitated integration of semantically related stimuli congruent with a semantic context (e.g., Blackford et al., 2012; Greenham et al., 2000; Janssen, Hernandez-Cabrera, van der Meij, & Barber, 2015; Piai et al., 2014).

Whereas electrophysiological studies investigating single word production mainly employed PWI and cyclic blocking tasks, comparable evidence for the continuous naming paradigm is rare. Up to now, only Costa and colleagues (2009) reported ERP effects of cumulative semantic interference associated with enhanced posterior positivity around 200 and 300 ms, and enhanced activity in the time window of the N400. Point-by-point correlation analysis revealed positive coherencies between naming latencies and ERPs between 208 and 388 ms suggesting that ERPs in this time window most likely reflect lexical processes. However, Llorens and colleagues combing the cyclic and continuous naming paradigm found no behavioral and electrophysiological effects for cumulative interference (please note, the design of this study is problematic in several ways, e.g., concerning counterbalancing of conditions, disuse of filler stimuli, etc.) (Llorens, Trebuchon, Ries, Liegeois-Chauvel, & Alario, 2014). Beside the investigation of behavioral semantic distance effects in Study 2, we also co-registered the EEG to gain further insights into the time course of cumulative interference in the continuous naming paradigm.

3. Summary of the present studies

In **Study 1,** we investigated cumulative semantic interference for associates in the continuous naming paradigm, since according to the trade-off assumption this paradigm is suitable for observing robust interference effects for associates. **Study 2** contributes to the assumption that semantic distance effects can be explained by the size of a lexical cohort because semantic distance was manipulated via taxonomic hierarchies in the continuous naming paradigm. Moreover, to shed light into the electrophysiological dynamics of cumulative interference, this study was conceived as an EEG study. Finally, in **Study 3**, we focused on the flexibility assumption of the SLN. In a PWI study with objects that have homophone names we examine whether semantic-lexical co-activation of unrelated meanings can be observed when participants process linguistic ambiguities in the form of puns.

3.1. Study 1: Associative cumulative interference

In this study, we investigated the impact of associative relations in the continuous naming paradigm. According to the SLN, this paradigm should be more suitable for observing associative interference because cumulative semantic interference is mainly characterized by a linear increase of lexical competition due to a learning mechanism. By contrast shared conceptual activation patterns decay relatively fast after a stimulus has been named due to unrelated items presented afterwards (Howard et al., 2006). Please note, that this assumption still holds by presuming that cumulative interference might originate from a learning mechanism at the conceptual level (Belke & Stielow, 2013; Riley, McMahon, & de Zubicaray, 2015), because the potential of a concept to activate its corresponding lemma is enhanced only during the trial at hand (for further details see Rose & Abdel Rahman, 2016). Thus, according to the trade-off assumption, the continuous

naming paradigm should reveal robust associative interference effects, since increasing levels of lexical competition dominate and outperform constant levels of conceptual facilitation.

Study 1 includes three different experiments using the same type of material, which consisted of objects (e.g., microscope) that were highly associated with a specific thematic context (e.g., laboratory). The presentation of those stimuli in isolation should activate their corresponding semantic frame such that cohort activation should be achieved (Bar, 2004; Bar & Aminoff, 2003; Bar & Ullman, 1996). In Experiment 1, the naming task was preceded by a free association task to ensure the recognition of themes. For this purpose, the themes were presented and participants were asked to name thematically associated concrete objects. In Experiment 2, the free association task was skipped. The aim of Experiment 3 was to replicate findings from Experiment 1 and 2 by controlling unsystematic categorical relations. When associations have the same potential to yield interference like category co-ordinates, and under the assumption that conceptual facilitation effects are minimized in the continuous naming paradigm, then associates should yield a linear increase across ordinal positions in all three experiments.

As predicted, robust cumulative semantic interference for associatively related stimuli emerged in all three experiments. Intriguingly, the size of the effects is comparable to effects reported for categorical relations (e.g., Belke, 2013; Belke & Stielow, 2013; Costa et al., 2009). For the very first time, these findings point to the fact that associative relations exert the same impact on semantic-lexical processes. Further, they add evidence to the trade-off assumption of the SLN.

3.2. Study 2: Semantic distance effects as function of lexical cohort activation

Even though all cumulative interference models would predict graded modulation of cumulative interference by semantic distance, this has not been yet investigated experimentally (cf. Alario & Moscoso del Prado Martín, 2010 for re-analysis of existing data sets). In this study, semantic distance was manipulated within taxonomic hierarchies to avoid problems with feature generation norms and semantic similarity ratings (Rose & Abdel Rahman, submitted). In this way, closely related stimuli consisted of members from a basic level category (e.g., apes) with high feature overlap between exemplars; distantly related items consisted of members from superordinate categories (e.g., animals) with moderate feature overlap. The broad category membership of stimuli was always constant (cf. Aristei & Abdel Rahman, 2013; Navarrete et al., 2010). This study can also specify assumptions of the lexical cohort account (Abdel Rahman & Melinger, 2009a, 2009b).

The stimulus material in Study 2 consisted of six superordinate categories (animals, clothes, tools, food, furniture and means of transportation) which were subdivided into 36 basic level categories (e.g., vermin, headgear, kitchen utensils, fruits, seating furniture and ships) each with six exemplars (e.g., camel, deer, horse, donkey, sheep, goat). Several confounding effects (e.g., transfer and regrouping effects) were meticulously controlled (cf. Alario & Moscoso del Prado Martín, 2010). Besides naming latencies, we also registered the EEG to gain information regarding the electrophysiological dynamic of cumulative interference. Cumulative interference models would assume a larger increase for closely than for distantly related items due to high degrees in feature overlap (Belke, 2013; Howard et al., 2006). Analogous to the predicted naming latency effects, we predicted differential modulations of ERPs as a function of semantic distance, particularly in the time window between 200 and 300 ms and of the N400.

Study 2 reveals significant effects in the naming latencies and ERPs only for closely related items, precisely picture naming latencies only increase linearly for closely but not distant related items. Closely related items evoked positive amplitude modulations over posterior electrodes between 100 and 150 ms (P1) and, analogous to Costa and colleagues, between 250 and 400 ms, and a negative posterior amplitude modulation between 450 and 600 ms (N400). Comparable to Costa and colleagues, the effect around 250 and 400 ms was positively correlated with naming latencies, and is interpreted to reflect lexical retrieval processes (Costa et al., 2009). However, we also found a negative correlation between latencies and effects in the N400 time window. This effect has been interpreted to represent the calibration of connection weights in the course of the postulated learning mechanism. The effect in the P1 amplitude prominent between the first and second ordinal position was not correlated with picture naming. This P1 modulation suggests a very early stage of visually induced conceptual ambiguity due high feature overlap of closely related stimuli.

Taken together, this study demonstrates by means of naming latencies and ERPs that, in contrast to cumulative interference models, only the activation levels of closely related items induce measurable interference effects. This enhances the understanding of the nature of the continuous naming paradigm. Even though this finding is at variance with the lexical cohort assumption, this can be easily integrated by the assumption that feature overlap mediates the impact of a lexical cohort via induced activation patterns (Abdel Rahman & Melinger, 2009a, 2009b; Melinger & Abdel Rahman, 2013). We could also replicate the findings by Costa and colleagues mainly that increase in latencies over ordinal position is correlated with a posterior positivity around 250 and 400 ms and yield significant N400 effects (Costa et al., 2009). In addition, we also found significant correlations with naming latencies in the N400 window, and report a modulation in the P1.

3.3. Study 3: Flexible co-activation of semantically unrelated meanings

The SLN predicts semantic context effects for semantic relations build on the fly (Abdel Rahman & Melinger, 2011). In study 3, we investigated the production of homonymous words in a PWI paradigm. Studies indicate that distractors categorically related to the non-depicted meaning (e.g., disco) of an object's homonymous name (e.g., ball) lead to phonological facilitation effects due to continuous activation flow (Cutting & Ferreira, 1999; Taylor & Burke, 2002). Importantly, these results do not assume that the alternative (non-depicted) meaning of the homophone gets co-activated during target naming per se. Interestingly, these alternative meanings of homophones play a crucial role in word plays or puns (e.g., "Two cannibals are eating a clown. One says to the other: 'It tastes kind of funny.'"), since their comprehension and appreciation depends on the identification of the word's ambiguous status and the synchronous co-activation of alternative meanings (amusing vs. strange) (Bekinschtein et al., 2011; Coulson & Severens, 2007; Sheridan, Reingold, & Daneman, 2009). In contrast, jokes do not rely on such ambiguity processing but on successful perspective shifting (e.g., "'Doctor, doctor, when I touch my knee it hurts and when I press on my butt it hurts as well.' – 'Hmm, yes, your finger is broken.'") (Bartolo, Benuzzi, Nocetti, Baraldi, & Nichelli, 2006; Bekinschtein et al., 2011; Coulson & Kutas, 2001; Coulson & Wu, 2005; Marinkovic et al., 2011; Moran, Wig, Adams, Janata, & Kelley, 2004). We thus presumed that repeated ambiguity processing in the form of puns would lead to a calibration of activation patterns within the language production system (cf. Chang, Dell, & Bock, 2006; van Gompel, Pickering, Pearson, & Jacob, 2006). According to the SLN, such an ambiguity processing mode would yield the co-activation of completely unrelated meanings when producing homophone words in the PWI.

Participants were divided into two groups. One group listened to puns, and the other group to jokes. Objects with ambiguous names were used as target pictures in the

PWI task. Each target (e.g., the German homophone "Schloss" [meaning alternatives: lock (depicted) and castle (non-depicted)]) was paired with a distractor word categorically related (e.g., palace) or unrelated (e.g., leg) to the non-depicted meaning of the homophone name. To enhance the probability of detecting semantic context effects on the fly, we additionally presented primes prior to target stimuli that could be either categorically related (e.g., bower) or unrelated (e.g., piano) to the non-depicted meaning of the object's name. We predicted that when an ambiguity processing mode is established participants in the puns group should yield larger facilitation effects for distractors categorically related with the non-depicted meaning then participants in the jokes group.

Naming responses were significantly facilitated for distractors semantically related to the non-depicted meaning only in the puns group, and as expected, this was only significant in combination with related primes. These results were validated by a procedure combining linear mixed models with crossed random effects for subjects and items (Baayen, Davidson, & Bates, 2008; Barr, Levy, Scheepers, & Tily, 2013) with a non-parametric bootstrap approach to investigate the distribution frequency with which facilitative effects could be replicated in the puns or jokes group. However, in contrast to what would have been expected in conjunction with studies showing facilitation for similar distractors without context manipulation, there was no phonological facilitation effect in the jokes group. Reasons for that might lay in experimental differences between these studies (Rose, Spalek, & Abdel Rahman, 2015). Importantly, in line with the flexibility assumption of the SLN, facilitation effects have been found in the puns group. These results show for the first time that a cognitive processing mode can modulate lexical-semantic activation patterns for completely semantically unrelated words.

4. General discussion

The present dissertation aimed to examine the assumptions of the SLN account (Abdel Rahman & Melinger, 2009a, 2009b). Study 1 confirmed the assumption that the output of language production processes is caused by a trade-off between semantic facilitation and lexical inhibition. By employing the continuous naming paradigm, robust associative interference could be observed which is usually shadowed by simultaneously (and constantly) triggered semantic facilitation effects. Study 2 elucidated the fact that besides the size of lexical cohort activation, the type of induced activation spread is also essential for semantic interference. Cumulative semantic interference effects were observed only for closely related items that activate a small lexical cohort suggesting that the impact of a lexical cohort is also mediated by semantic feature overlap. Finally, Study 3 shows that language production is highly shapeable by situational circumstances. We observed semantic context effects for completely unrelated alternative meanings of homophones when the cognitive system was in an ambiguity processing mode. Altogether, the findings of all three studies point to the fact that language production is much more flexible and adaptive as has been assumed. There are several semantic and cognitive factors beyond strict taxonomic boundaries that affect word production and further discussion about lexical selection have to account for these factors. The SLN account provides a comprehensive framework for the reported findings.

4.1. What makes a cohort swing?

Considering the robustness of associative interference, small interference effects for associates reported thus far in the cyclic blocking and PWI paradigm should be interpreted with regard to the applied paradigms (Rose & Abdel Rahman, 2016). For the first time, robust associative interference has been observed in three different experiments using the

continuous naming paradigm in Study 1. Moreover, these interference effects were equally comparable in size as for categorical relations effects (e.g., Belke, 2013; Belke & Stielow, 2013; Costa et al., 2009). Irrespective of whether associative ties have been highlighted (Experiment 1 vs. 2) or associative relations have been controlled regarding unsystematic categorical overlap (Experiment 3), there were no significant differences in associative interference across experiments. According to the SLN, a paradigm that is characterized by constant levels of conceptual activation but linearly increasing levels of competition from a lexical cohort provides a trade-off that is favorable for associative interference (cf. Abdel Rahman & Melinger, 2007).

In contrast to the lexical cohort assumption of the SLN, only closely related items yield semantic interference in the continuous naming paradigm (Study 2). However, this result can be principally integrated in the SLN since it also emphasizes the importance of converging activation patterns. Lexical cohort activation is characterized by activated entries that mutually enhance each other and build up converging activation (Abdel Rahman & Melinger, 2009b; Melinger & Abdel Rahman, 2013). Thus, apart from the number of active lexical competitors (Study 1) one important mediating factor is the degree and type of feature overlap. While activation spread from many specific features aggregates on a narrow cluster of tightly related competitors, activation from less and more general features diverges on loosely related competitors and is unable to obtain an activation pattern leading to convergence (cf. Belke, 2013).

However, the SLN assumes that associative and categorical relations differ in their potential to induce the activation of a lexical cohort, because, in contrast to categorically related stimuli, associatively related stimuli exhibit less feature overlap and are thus unlikely to induce the simultaneous activation of many interrelated items (Melinger & Abdel Rahman, 2013). This interpretation stands in contrast with the results from Study 2

investigating semantic distance by holding the broad category membership constant. While associates with low feature overlap but high associative ties lead to an increasing number of activated competitors across ordinal positions (Study 1), co-ordinates with low feature overlap but from the same superordinate category do not induce interference. There are at least two plausible scenarios that can explain this pattern.

First, the semantic system might be characterized by two different levels of representation, as has been proposed by the "featural and unitary semantic space" (FUSS) model developed by Vigliocco and colleagues (Vigliocco et al., 2004; see also Belke, 2013). This model consists of distributed conceptual features (e.g., vivid, carnivore, has legs, fur, etc.) and of amodal unitary lexical concepts (e.g., fox, stone, wine) binding these features. Due to their complementary roles and co-occurrence in daily life, it is assumed that during transformation from episodic to semantic memory, associative relations (e.g., alarm clock and bed) are represented by connections between lexical concepts (Cree & McRae, 2003; Estes et al., 2011; Vigliocco et al., 2004). Accordingly, associative interference would originate irrespective of feature overlap from strong semantic ties between other related associates on the level of amodal representations leading to the activation of an increasing amount of lexical competitors. On the contrary, as discussed above, semantic interference for closely related items mainly arises due their conceptual feature overlap. Precisely, since objects are named by their subordinate name (e.g., orangutan, chimpanzee, etc.), they have to be identified by their specific and individualizing features (Belke, 2013). Due to the high similarity of closely related items (in contrast to distantly related items), their specific feature overlap provides the activation of numerous lexical concepts. The value of such a model for the continuous and cyclic blocking paradigm had been discussed by Belke (2013), and is supported by studies showing significant influences of specific feature configurations for semantically related stimuli (e.g., Clarke, Taylor, Deveurex, Randall, & Tyler, 2013; Moss, Rodd, Stamatakis,

Bright, & Tyler, 2005; Sailor & Brooks, 2014; Vieth, McMahon, Cunnington, & de Zubicaray, 2015; Vieth, McMahon, & de Zubicaray, 2014b).

Alternatively, the findings of Study 1 and 2 also specify decisive factors driving interference in the continuous naming paradigm. Irrespective of the categorical or associative nature of semantic relations, and the kind of feature overlap, the competitive situation in this paradigm is defined by the activation patterns during the trial at hand and by increasing activity levels of competitors across ordinal positions due to priming after lemma retrieval (Belke, 2013; Howard et al., 2006). Thus, interference for associative or taxonomically close relations is found because these relations consist of a well-defined and highly-active cohort, as described above, and thus achieve to ballistically activate a sufficiently large amount of co-activation in the course of target presentation.

Tentatively, both of these scenarios could gain support by the finding of a P1 modulation in Study 2. This early effect seems to represent early perceptual driven co-activation of visual/conceptual features (Clarke et al., 2013; Moss et al., 2005). The fact that effects in such time windows are prone to manipulation of feature distinctness and intra-categorical structural similarities underlines the important role that feature overlap plays in the continuous naming paradigm. Moreover, this effect precedes effects that are between 250 and 400 ms and 400 and 600 ms, which are probably associated with lexical retrieval and calibrations of the semantic-lexical connection strength. This P1 could mark a very early state of conceptual ambiguity that is capable of initiating semantic-lexical co-activation at later stages, and activation of a cohort characterized by converging activation. However, whether this interpretation holds true in the continuous naming paradigm needs further research, and more sophisticated EEG analysis (e.g., in the form of source analysis and dipole localization).

There is a limitation in Studies 1 and 2 considering the question whether lexical selection is competitive or not. Predictions made by competitive and non-competitive accounts of cumulative interference are hardly distinguishable by behavioral measures. According to the model of Oppenheim and colleagues (2010) behavioral results observed in Study 1 and 2 may be interpreted in favor of incremental learning without lexical competition. Their model assumes that cumulative interference is a consequence of an incremental learning mechanism enhancing target representations and in parallel inhibiting semantically related non-target representations. Especially, the inhibition mechanism in the form of retrieval induced forgetting (RIF) make the assumption of lexical competition obsolete. However, RIF has been associated with positive ERP deflections over frontal electrode sites (Hellerstedt & Johansson, 2014; Johansson, Aslan, Bauml, Gabel, & Mecklinger, 2007; Spitzer, Hanslmayr, Opitz, Mecklinger, & Bauml, 2009). An additional analysis over these regions in Study 2 yielded no significant ERP effects (cf. de Zubicaray et al., 2013; Ries et al. 2015). As the purpose of Study 2 was to test semantic distance effects, we cannot finally exclude RIF as viable alternative. Even though the reviewed results add evidence to the SLN account, they were not aimed to distinguish unequivocally between competitive and non-competitive accounts for lexical selection in the continuous naming paradigm.

4.2. Flexible language production

Study 3 presents evidence for the flexible adjustability of word production processes. Findings suggest that alternative and completely unrelated meanings of an ambiguous word are simultaneously co-activated in a PWI task, when the language production system is modulated by processing of linguistic ambiguities in the form of puns. Processing of ambiguities created a cognitive processing mode that improves not

only the identification of word ambiguities by enhancing phonological feedback connections (Burke, Locantore, Austin, & Chae, 2004; Damian & Martin, 1999; Ferreira & Griffin, 2003) but also the likelihood that unrelated meanings get co-activated (cf. Joubert, Fize, Rousselet, & Fabre-Thorpe, 2008). Apparently, the language production system flexibly adapts due to interaction with different situative conditions.

Yet, facilitative effects per se might not unequivocally stand for the co-activation of meaning alternatives since this should result in higher lexical competition and interference effects. According to the SLN, inhibitory effects should depend on the activation of a sufficient size of semantically related lexical competitors. Alternative meanings might activate other semantically related concepts from their category but this activation will not converge on the same lexical entities (cf. Melinger & Abdel Rahman, 2013). Moreover, distractors related to the non-depicted meaning of a homophone name already facilitate phonological encoding. The emerging amount of competitors was just too small to outweigh conceptual and phonological facilitation effects. More importantly, facilitation has been only found in the puns group as would be expected by the flexibility assumption of the SLN (Rose, Spalek, Abdel Rahmen, 2015).

Further support for the flexibility of the language production system comes from a side-result of Study 1, namely, that the distinction between categorical and associative relations is not an absolute measure. By scholastic definition, associations are characterized among others by complementary roles that entities serve, e.g., during an event, without considerable categorical feature overlap. However, some objects in Experiment 1 and 2 of Study 1 also unsystematically exhibited categorical relationships (Rose & Abdel Rahman, 2016). In fact, many associates can be also category coordinates (e.g., tank and jet fighter (vehicles) from the military theme). Nevertheless, irrespective of that, the exchange of these objects presented in Experiment 3 did not significantly diminish

the size of interference. Apparently, the organization of the semantic system is more shaped via meaningful interactions with the environment than influenced by principal differences between associative and categorical relations (cf. Jackson, Hoffman, Pobric, & Ralph, 2015).

5. Conclusion

While retrieving words from the mental lexicon seems to be effortless, language production relies on complex interaction of conceptual, lexical and phonological processes. Results from three studies suggest that the microstructure of the language production system is flexibly shapeable, and relies on the number of co-activated lexical entities as well as their feature overlap. The impact of activation spread on interference in the continuous naming paradigm is determined by the potential of targets to ballistically activate semantically related concepts. Lexical retrieval for closely related items is associated with posterior ERP modulations in the P1, between 250 and 400ms and in the N400 time window, representing different aspects of semantic-lexical processes serving language production. Importantly, whether concept and lexical nodes get activated is not limited by hard wired memory structures and taxonomic hierarchies but can be dynamically induced by situational conditions.

6. References

Abdel Rahman, R., & Melinger, A. (2007). When bees hamper the production of honey: Lexical interference from associates in speech production. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*(3), 604-614.

Abdel Rahman, R., & Melinger, A. (2009a). Dismissing lexical competition does not make speaking any easier: A rejoinder to Mahon and Caramazza (2009). *Language and Cognitive Processes, 24*(5), 749-760.

Abdel Rahman, R., & Melinger, A. (2009b). Semantic context effects in language production: A swinging lexical network proposal and a review. *Language and Cognitive Processes, 24*(5), 713-734.

Abdel Rahman, R., & Melinger, A. (2011). The Dynamic Microstructure of Speech Production: Semantic Interference Built on the Fly. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 37*(1), 149-161.

Alario, F. X., & Moscoso del Prado Martín, F. (2010). On the origin of the "cumulative semantic inhibition" effect. *Memory & Cognition, 38*(1), 57-66.

Alario, F. X., Segui, J., & Ferrand, L. (2000). Semantic and associative priming in picture naming. *Quarterly Journal of Experimental Psychology Section: Human Experimental Psychology, 53*(3), 741-764.

Aristei, S., & Abdel Rahman, R. (2013). Semantic interference in language production is due to graded similarity, not response relevance. *Acta Psychologica, 144*(3), 571-582.

Aristei, S., Melinger, A., & Abdel Rahman, R. (2010). Electrophysiological Chronometry of Semantic Context Effects in Language Production. *Journal of Cognitive Neuroscience*.

Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language, 59*(4), 390-412.

Bar, M. (2004). Visual objects in context. *Nature Reviews Neuroscience, 5*(8), 617-629.

Bar, M., & Aminoff, E. (2003). Cortical analysis of visual context. *Neuron, 38*(2), 347-358.

Bar, M., & Ullman, S. (1996). Spatial context in recognition. *Perception, 25*(3), 343-352.

Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language, 68*(3), 255-278.

Barsalou, L. W. (1983). Ad Hoc Categories. *Memory & Cognition, 11*(3), 211-227.

Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology, 59*, 617-645.

Bartolo, A., Benuzzi, F., Nocetti, L., Baraldi, P., & Nichelli, P. (2006). Humor comprehension and appreciation: An fMRI study. *Journal of Cognitive Neuroscience, 18*(11), 1789-1798.

Bekinschtein, T. A., Davis, M. H., Rodd, J. M., & Owen, A. M. (2011). Why clowns taste funny: the relationship between humor and semantic ambiguity. *The Journal of Neuroscience, 31*(26), 9665-9671.

Belke, E. (2013). Long-lasting inhibitory semantic context effects on object naming are necessarily conceptually mediated: Implications for models of lexical-semantic encoding. *Journal of Memory and Language, 69*(3), 228-256.

Belke, E., Meyer, A. S., & Damian, M. (2005). Refractory effects in picture naming as assessed in a semantic blocking paradigm. *Quarterly Journal of Experimental Psychology Section: Human Experimental Psychology, 58*(4), 667-692.

Belke, E., & Stielow, A. (2013). Cumulative and non-cumulative semantic interference in object naming: Evidence from blocked and continuous manipulations of semantic context. *Quarterly Journal of Experimental Psychology, 66*(11), 2135-2160.

Blackford, T., Holcomb, P. J., Grainger, J., & Kuperberg, G. R. (2012). A funny thing happened on the way to articulation: N400 attenuation despite behavioral interference in picture naming. *Cognition, 123*(1), 84-99.

Bloem, I., van den Boogaard, S., & La Heij, W. (2004). Semantic facilitation and semantic interference in language production: Further evidence for the conceptual selection model of lexical access. *Journal of Memory and Language, 51*(2), 307-323.

Burke, D. M., Locantore, J. K., Austin, A. A., & Chae, B. (2004). Cherry pit primes Brad Pitt - Homophone priming effects on young and older adults' production of proper names. *Psychological Science, 15*(3), 164-170.

Chang, F., Dell, G. S., & Bock, K. (2006). Becoming syntactic. *Psychological Review, 113*(2), 234-272.

Clarke, A., Taylor, K. I., Deveurex, B., Randall, B., & Tyler, L. K. (2013). From perception to conception: How the meaning of visual objects emerges over time. *Perception, 40*, 32-32.

Costa, A., Alario, F. X., & Caramazza, A. (2005). On the categorical nature of the semantic interference effect in the picture-word interference paradigm. *Psychonomic Bulletin & Review, 12*(1), 125-131.

Costa, A., Strijkers, K., Martin, C., & Thierry, G. (2009). The time course of word retrieval revealed by event-related brain potentials during overt speech. *Proceedings of the National Academy of Sciences of the United States of America, 106*(50), 21442-21446.

Coulson, S., & Kutas, M. (2001). Getting it: human event-related brain response to jokes in good and poor comprehenders. *Neuroscience Letters, 316*(2), 71-74.

Coulson, S., & Severens, E. (2007). Hemispheric asymmetry and pun comprehension: When cowboys have sore calves. *Brain and Language, 100*(2), 172-187.

Coulson, S., & Wu, Y. C. (2005). Right hemisphere activation of joke-related information: An event-related brain potential study. *Journal of Cognitive Neuroscience, 17*(3), 494-506.

Cree, G. S., & McRae, K. (2003). Analyzing the factors underlying the structure and computation of the meaning of chipmunk, cherry, chisel, cheese, and cello (and many other such concrete nouns). *Journal of Experimental Psychology-General, 132*(2), 163-201.

Cutting, J. C., & Ferreira, V. S. (1999). Semantic and phonological information flow in the production lexicon. *Journal of Experimental Psychology. Learning, Memory, and Cognition, 25*(2), 318-344.

Damian, M. F., & Als, L. C. (2005). Long-lasting semantic context effects in the spoken production of object names. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 31*(6), 1372-1384.

Damian, M. F., & Bowers, J. S. (2003). Locus of semantic interference in picture-word interference tasks. *Psychonomic Bulletin & Review, 10*(1), 111-117.

Damian, M. F., & Martin, R. C. (1999). Semantic and phonological codes interact in single word production. *Journal of Experimental Psychology. Learning, Memory, and Cognition, 25*(2), 345-361.

Damian, M. F., Vigliocco, G., & Levelt, W. J. M. (2001). Effects of semantic context in the naming of pictures and words. *Cognition, 81*(3), B77-B86.

de Zubicaray, Hansen, S., & McMahon, K. L. (2013). Differential processing of thematic and categorical conceptual relations in spoken word production. *Journal of experimental psychology. General, 142*(1), 131-142.

de Zubicaray, Johnson, K., Howard, D., & McMahon, K. (2014). A perfusion fMRI investigation of thematic and categorical context effects in the spoken production of object names. *Cortex, 54*, 135-149.

de Zubicaray, McMahon, K., & Howard, D. (2013). Perfusion fMRI evidence for priming of shared feature-to-lexical connections during cumulative semantic interference in spoken word production. *Language and Cognitive Processes*.

Dell'Acqua, R., Sessa, P., Peressotti, F., Mulatti, C., Navarrete, E., & Grainger, J. (2010). ERP evidence for ultra-fast semantic processing in the picture-word interference paradigm. *Frontiers in Psychology, 1*.

Dell, G. S. (1986). A Spreading-Activation Theory of Retrieval in Sentence Production. *Psychological Review, 93*(3), 283-321.

Dell, G. S., & O'Seaghdha, P. G. (1991). Mediated and convergent lexical priming in language production: a comment on Levelt et al. (1991). *Psychological Review, 98*(4), 604-614.

Estes, Z., Golonka, S., & Jones, L. L. (2011). Thematic Thinking: The Apprehension and Consequences of Thematic Relations. *Psychology of Learning and Motivation: Advances in Research and Theory, Vol 54, 54*, 249-294.

Ferreira, V. S., & Griffin, Z. M. (2003). Phonological influences on lexical (mis)selection. *Psychological Science, 14*(1), 86-90.

Glaser, W. R., & Dungelhoff, F. J. (1984). The Time Course of Picture Word Interference. *Journal of Experimental Psychology: Human Perception and Performance, 10*(5), 640-654.

Glaser, W. R., & Glaser, M. O. (1989). Context Effects in Stroop-Like Word and Picture-Processing. *Journal of Experimental Psychology: General, 118*(1), 13-42.

Greenham, S. L., Stelmack, R. M., & Campbell, K. B. (2000). Effects of attention and semantic relation on event-related potentials in a picture-word naming task. *Biological Psychology, 55*(2), 79-104.

Hantsch, A., Jescheniak, J. D., & Schriefers, H. (2005). Semantic competition between hierarchically related words during speech planning. *Memory & Cognition, 33*(6), 984-1000.

Hellerstedt, R., & Johansson, M. (2014). Electrophysiological Correlates of Competitor Activation Predict Retrieval-Induced Forgetting. *Cerebral Cortex, 24*(6), 1619-1629.

Howard, D., Nickels, L., Coltheart, M., & Cole-Virtue, J. (2006). Cumulative semantic inhibition in picture naming: experimental and computational studies. *Cognition, 100*(3), 464-482.

Hutson, J., & Damian, M. F. (2014). Semantic gradients in picture-word interference tasks: is the size of interference effects affected by the degree of semantic overlap? *Frontiers in Psychology, 5*.

Jackson, R. L., Hoffman, P., Pobric, G., & Ralph, M. A. L. (2015). The Nature and Neural Correlates of Semantic Association versus Conceptual Similarity. *Cerebral Cortex, 25*(11), 4319-4333.

Janssen, N., Hernandez-Cabrera, J. A., van der Meij, M., & Barber, H. A. (2015). Tracking the Time Course of Competition During Word Production: Evidence for a Post-Retrieval Mechanism of Conflict Resolution. *Cereb Cortex, 25*(9), 2960-2969.

Johansson, M., Aslan, A., Bauml, K. H., Gabel, A., & Mecklinger, A. (2007). When remembering causes forgetting: Electrophysiological correlates of retrieval-induced forgetting. *Cerebral Cortex, 17*(6), 1335-1341.

Joubert, O. R., Fize, D., Rousselet, G. A., & Fabre-Thorpe, M. (2008). Early interference of context congruence on object processing in rapid visual categorization of natural scenes. *Journal of Vision, 8*(13), 11 11-18.

Kroll, J. F., & Stewart, E. (1994). Category Interference in Translation and Picture Naming - Evidence for Asymmetric Connections between Bilingual Memory Representations. *Journal of Memory and Language, 33*(2), 149-174.

La Heij, W., Dirkx, J., & Kramer, P. (1990). Categorical Interference and Associative Priming in Picture Naming. *British Journal of Psychology, 81*, 511-525.

Levelt, W.J. (1992). Accessing words in speech production: stages, processes and representations. *Cognition, 42*(1-3), 1-22.

Levelt, W.J., Roelofs, A., & Meyer, A. S. (1999). A theory of lexical access in speech production. *The Behavioral and Brain Sciences, 22*(1), 1-38; discussion 38-75.

Llorens, A., Trebuchon, A., Ries, S., Liegeois-Chauvel, C., & Alario, F. X. (2014). How familiarization and repetition modulate the picture naming network. *Brain Lang, 133*, 47-58.

Maess, B., Friederici, A. D., Damian, M., Meyer, A. S., & Levelt, W. J. M. (2002). Semantic category interference in overt picture naming: Sharpening current density localization by PCA. *Journal of Cognitive Neuroscience, 14*(3), 455-462.

Mahon, B. Z., Costa, A., Peterson, R., Vargas, K. A., & Caramazza, A. (2007). Lexical selection is not by competition: A reinterpretation of semantic interference and facilitation effects in the picture-word interference paradigm. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*(3), 503-535.

Marinkovic, K., Baldwin, S., Courtney, M. G., Witzel, T., Dale, A. M., & Halgren, E. (2011). Right hemisphere has the last laugh: neural dynamics of joke appreciation. *Cognitive Affective & Behavioral Neuroscience, 11*(1), 113-130.

McRae, Ken, Khalkhali, Saman, & Hare, Mary. (2012). Semantic and associative relations in adolescents and young adults: Examining a tenuous dichotomy. In Valerie F. Reyna, Sandra B. Chapman, Michael R. Dougherty & Jere Confrey (Eds.), *The adolescent brain: Learning, reasoning, and decision making* (Vol. xviii, pp. pp. 39-66). Washington, DC, US: American Psychological Association.

Melinger, A., & Abdel Rahman, R. (2013). Lexical Selection Is Competitive: Evidence From Indirectly Activated Semantic Associates During Picture Naming. *Journal of Experimental Psychology: Learning, Memory and Cognition, 39*(2), 348-364.

Moran, J. M., Wig, G. S., Adams, R. B., Janata, P., & Kelley, W. M. (2004). Neural correlates of humor detection and appreciation. *Neuroimage, 21*(3), 1055-1060.

Moss, H. E., Rodd, J. M., Stamatakis, E. A., Bright, P., & Tyler, L. K. (2005). Anteromedial temporal cortex supports fine-grained differentiation among objects. *Cerebral Cortex, 15*(5), 616-627.

Muehlhaus, J., Heim, S., Sachs, O., Schneider, F., Habel, U., & Sass, K. (2013). Is the Motor or the Garage More Important to the Car? The Difference Between Semantic Associations in Single Word and Sentence Production. *Journal of Psycholinguistic Research, 42*(1), 37-49.

Navarrete, E., Del Prato, P., & Mahon, B. Z. (2012). Factors determining semantic facilitation and interference in the cyclic naming paradigm. *Frontiers in Psychology, 3*.

Navarrete, E., Del Prato, P., Peressotti, F., & Mahon, B. Z. (2014). Lexical selection is not by competition: Evidence from the blocked naming paradigm. *Journal of Memory and Language, 76*, 253-272.

Navarrete, E., Mahon, B. Z., & Caramazza, A. (2010). The cumulative semantic cost does not reflect lexical selection by competition. *Acta Psychologica, 134*(3), 279-289.

Oppenheim, G. M., Dell, G. S., & Schwartz, M. F. (2010). The dark side of incremental learning: A model of cumulative semantic interference during lexical access in speech production. *Cognition, 114*(2), 227-252.

Piai, V., Roelofs, A., Jensen, O., Schoffelen, J. M., & Bonnefond, M. (2014). Distinct Patterns of Brain Activity Characterise Lexical Activation and Competition in Spoken Word Production. *Plos One, 9*(2).

Piai, V., Roelofs, A., & van der Meij, R. (2012). Event-related potentials and oscillatory brain responses associated with semantic and Stroop-like interference effects in overt naming. *Brain Research, 1450*, 87-101.

Riès, S. K., Karzmark, C. R., Navarrete, E., Knight, R. T., & Dronkers, N. F. (2015). Specifying the role of the left prefrontal cortex in word selection. *Brain Lang, 149*, 135-147.

Riley, E., McMahon, K. L., & de Zubicaray, G. (2015). Long-lasting semantic interference effects in object naming are not necessarily conceptually mediated. *Frontiers in Psychology, 6*.

Roelofs, A. (1992). A spreading-activation theory of lemma retrieval in speaking. *Cognition, 42*(1-3), 107-142.

Roelofs, A. (2003). Goal-referenced selection of verbal action: Modelling attentional control in the Stroop task. *Psychological Review, 110*(1), 88-125.

Roelofs, A., & Piai, V. (2013). Associative facilitation in the Stroop task: Comment on Mahon et al. (2012). *Cortex, 49*(6), 1767-1769.

Roelofs, A., & Piai, V. (2015). Aspects of competition in word production: Reply to Mahon and Navarrete. *Cortex, 64*, 420-424.

Rose, S. B., Spalek, K., & Abdel Rahman, R. (2015). Listening to Puns Elicits the Co-Activation of Alternative Homophone Meanings during Language Production. *Plos One, 10*(6).

Rose, S.B., & Abdel Rahman, R. (2016). Cumulative semantic interference for associative relations in language production. *Cognition, 152*, 20-31.

Rose, S.B., & Abdel Rahman, R. (submitted). Semantic similarity promotes interference in the continuous naming paradigm: Behavioral and electrophysiological evidence.

Runnqvist, E., Strijkers, K., Alario, F. X., & Costa, A. (2012). Cumulative semantic interference is blind to language: Implications for models of bilingual speech production. *Journal of Memory and Language, 66*(4), 850-869.

Sailor, K., & Brooks, P. J. (2014). Do part-whole relations produce facilitation in the picture-word interference task? *Quarterly Journal of Experimental Psychology, 67*(9), 1768-1785.

Schnur, T. T., Schwartz, M. F., Brecher, A., & Hodgson, C. (2006). Semantic interference during blocked-cyclic naming: Evidence from aphasia. *Journal of Memory and Language, 54*(2), 199-227.

Schriefers, H., Meyer, A. S., & Levelt, W. J. M. (1990). Exploring the Time Course of Lexical Access in Language Production - Picture-Word Interference Studies. *Journal of Memory and Language, 29*(1), 86-102.

Sheridan, H., Reingold, E. M., & Daneman, M. (2009). Using puns to study contextual influences on lexical ambiguity resolution: Evidence from eye movements. *Psychonomic Bulletin & Review, 16*(5), 875-881.

Spitzer, B., Hanslmayr, S., Opitz, B., Mecklinger, A., & Bauml, K. H. (2009). Oscillatory Correlates of Retrieval-induced Forgetting in Recognition Memory. *Journal of Cognitive Neuroscience, 21*(5), 976-990.

Strijkers, K., Costa, A., & Thierry, G. (2010). Tracking lexical access in speech production: electrophysiological correlates of word frequency and cognate effects. *Cerebral Cortex, 20*(4), 912-928.

Taylor, J. K., & Burke, D. M. (2002). Asymmetric aging effects on semantic and phonological processes: Naming in the picture-word interference task. *Psychology and Aging, 17*(4), 662-676.

van Gompel, R. P. G., Pickering, M. J., Pearson, J., & Jacob, G. (2006). The activation of inappropriate analyses in garden-path sentences: Evidence from structural priming. *Journal of Memory and Language, 55*(3), 335-362.

Vieth, H. E., McMahon, K. L., Cunnington, R., & de Zubicaray, G. I. (2015). Interference from object part relations in spoken word production: Behavioural and fMRI evidence. *Journal of Neurolinguistics, 36*, 56-71.

Vieth, H. E., McMahon, K. L., & de Zubicaray, G. I. (2014a). Feature overlap slows lexical selection: Evidence from the picture–word interference paradigm. *The Quarterly Journal of Experimental Psychology*, 1-15.

Vieth, H. E., McMahon, K. L., & de Zubicaray, G. I. (2014b). The roles of shared vs. distinctive conceptual features in lexical access. *Frontiers in Psychology, 5*.

Vigliocco, G., Vinson, D. P., Damian, M. F., & Levelt, W. (2002). Semantic distance effects on object and action naming. *Cognition, 85*(3), B61-B69.

Vigliocco, G., Vinson, D. P., Lewis, W., & Garrett, M. F. (2004). Representing the meanings of object and action words: The featural and unitary semantic space hypothesis. *Cognitive Psychology, 48*(4), 422-488.

7. Original articles

1. Rose, S. B., Abdel Rahman, R. (2016). Cumulative semantic interference for associative relations in language production. *Cognition*, 152, 20-31. http://dx.doi.org/10.1016/j.cognition.2016.03.013
2. Rose, S. B., Abdel Rahman, R. (2016). Semantic similarity promotes inter-ference in the continuous naming paradigm: Behavioral and electrophysiological evidence. *Language, Cognition, and Neuroscience*. http://dx.doi.org/10.1080/23273798.2016.1212081
3. Rose, S. B., Spalek, K., & Rahman, R. A. (2015). Listening to puns elicits the co-activation of alternative homophone meanings during language production. *PloS one*, 10(6). http://dx.doi.org/10.1371/journal.pone.0130853

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Eidesstattliche Erklärung

Hiermit erkläre ich an Eides statt,

1. dass ich die vorliegende Arbeit selbständig und ohne unerlaubte Hilfe verfasst habe,
2. dass ich mich nicht anderwärts um einen Doktorgrad beworben habe und noch keinen Doktorgrad der Psychologie besitze,
3. dass mir die zugrunde liegende Promotionsordnung vom 3. August 2006 bekannt ist.

Berlin, den 31.3.2016

Sebastian Benjamin Rose